

Comparative CAD/CAE-based Structural and Dynamic Analysis of Aluminum Alloy Wheel Rim

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Abstract:

This research focuses on the design and performance evaluation of a wheel rim for the Kia Carnival Prestige using computer-aided design and engineering tools. The central objective was to compare two aluminum alloys, Al-7075 and Al-7068, and determine which material delivers better performance under realistic loading conditions. The rim was modelled in SolidWorks according to manufacturer dimensions, and its behaviour was studied through finite element analysis in ANSYS. Both structural and dynamic boundary conditions were applied, with load cases representing vehicle operation under three-passenger and five-passenger configurations. The simulations assessed critical parameters such as stress distribution, total deformation, equivalent strain, and safety factors. The results demonstrated that Al-7068 consistently outperformed Al-7075, showing reduced stress levels, lower deformation, and higher safety margins in both loading conditions. Although the five-passenger case naturally produced greater stress and deformation compared to the three-passenger scenario, Al-7068 maintained stability and remained within safe design limits. The findings confirm that material selection plays a decisive role in the strength, durability, and service life of automotive rims. With its superior strength-to-weight ratio, lighter mass, and ability to sustain higher loads without compromising safety, Al-7068 emerges as the more suitable material for high-speed and heavy-duty vehicle applications. This study highlights the value of combining advanced material science with CAD/CAE-based simulations to optimize automotive components, reduce failure risks, and enhance overall vehicle performance.

Keywords:

Ansys Simulation, Automotive, Wheel Rim, Structural Analysis, CAD.